THE PURPOSE of the study was to assess the relative effectiveness of print, sign, and pictures in the transfer of reading-related information to children who are deaf. By means of personal computers, deaf children were presented CD-ROM-generated stories in four different formats: print only, print plus pictures, print plus sign language, and print plus pictures plus sign. A repeated-measure design was used to analyze participants’ reading comprehension performance. Significant differences were found among the four presentation options. One observed phenomenon was that participants would switch from American Sign Language to Signed English when analyzing text. The study findings suggest that presenting stories on CD-ROM with multiple modes of reading cues, such as print, pictures, and sign language, may be an enjoyable and interesting supplement to standard reading practices.

Children who are born deaf typically do not possess the experience, cognitive skills, and linguistic base necessary to achieve reading fluency beyond a fourth-grade level (King & Quigley, 1985). Karchmer and Trybus (1977) found that the median reading score (grade equivalent) of deaf students age 20 years and older was 4.5, with only 10% of them reading at or above the eighth-grade level. These data are comparisons of deaf students’ scores relative to norms developed with hearing students (Moores, 1996). The Center for Assessment and Demographic Studies, Gallaudet University, published a report on Stanford Achievement Test scores from the 1989–1990 school year. In part, the report compared grade equivalency scores of 15-year-old hearing students with the scores of comparably aged deaf and hard of hearing students. This comparison indicated that the average hearing 15-year-old read at the 10th-grade level. The average deaf or hard of hearing 15-year-old, however, read only at the fourth-grade level (Holt, 1993).

Too often, the deaf child brings an impoverished knowledge base and weak English skills to the reading process. The reading problems of children who are deaf are thought to be linked to early English-language deprivation and associated linguistic deficiencies.

Literacy skills have been a major concern of educators of deaf children...
for decades. Regardless of the teaching methods used with deaf children, their literacy skills continue to lag considerably behind those of their hearing peers.

Low literacy levels affect deaf students’ ability to learn in the classroom. Many educators presume to assist deaf students to compensate by adapting materials (i.e., by rewriting texts to control syntax, vocabulary, and figurative language) and, increasingly, by using multimedia technology (King & Quigley, 1985).

Technology and Education
Computers have had a major impact on education over the past 25 years. From payroll accounting to enrollment monitoring, from educational diagnostics to computerized instruction, from the production of daily lesson plans to typing instruction, and from finding information to hooking up to the Internet, computers have affected educational institutions in significant ways.

Lane (1984) reported that, by the early 1980s, at least half of all school districts in the United States were using computers for educational and administrative tasks. About a decade later, the Office of Technology Assessment reported that 5.8 million computers were being used in schools in the United States (Byrom, 1997). About the same time, McDonald, Lynch, and Kearsley (1996) placed the student-to-computer ratio in U.S. public schools at 10:1. A total of $4.3 billion in educational technology expenditures were reported to have been made in K—12 public schools in the 1996–1997 school year (Byrom, 1997). Clearly, by the late 1990s computers had become an integral part of classroom education in the United States.

Since the early 1980s, computers have also gained rapid acceptance in schools for deaf children (Mackall, 1996; Rose & Waldon, 1984). Deninger reported in 1985 that 76% of all deaf education programs were using computers for instruction. Ninety-six percent of state residential schools for the deaf report using computers as instructional aids; computers are used in most programs for students who are deaf or hard of hearing (Mackall, 1996).

Computer Development
Historically, computers have been used as tools for handling data. The first electronic computer was developed in Great Britain in 1943; another early version was developed in the United States within a few years. These first computers were developed primarily for military tasks such as breaking codes and computing trajectories. They were approximately the size of a small house, and contained mazes of wiring, vacuum tubes, switches, and resistors. They were plagued by mechanical failures and could perform only a single function (Evans, 1981; Richardson, 1983). In the past 50 years, the electronic computer has evolved into a machine that can fit in a briefcase, is much faster, more reliable, and relatively inexpensive, is capable of storing and handling vast amounts of information, and has the ability to perform an unlimited number of intricate tasks.

The birth of the microcomputer played an important role in the computer revolution. The number of microcomputers sold in 1981 reached 1.4 million. Approximately $3.1 billion worth of computers were sold in 1982; the figure more than doubled, to $7.4 billion, in 1983. From 1981 to 1991, personal computer sales increased nearly 10-fold, from $3.9 billion to $37 billion. During that same period, the number of microcomputers used in schools also grew at a dramatic rate (Greenwood, 1994). In 1996, McDonald and colleagues reported that most schools had computers. They further reported that more than 22,000 schools in the United States, that is, 28%, had more than 50 computers.

Software Applications
Educational programs or software used with microcomputers are usually of five basic types: drill and practice, tutorial, simulation, problem solving, and tool (Simonson & A. Thompson, 1990).

Drill and Practice
Drill and practice programs reinforce concepts that have previously been taught. In 1963, Patrick Suppes and Richard Atkinson of Stanford University produced computer programs that elicited a student response, provided immediate feedback, and then presented another problem of appropriate difficulty. Such software provides an unlimited amount of practice for skills without repeating data for a learning session. A large portion of the early research on computer-assisted instruction (CAI) focused on analyzing the effectiveness of the drill and practice approach (A. Thompson, Simonson, & Hargrave, 1992).

Tutorial
Tutorial programs introduce new concepts through a programmed-learning format and can involve extensive computer/student interaction. The computer software describes the concept to be taught and then provides examples and practice problems. Much of the research done on these types of programs concerned the question, “Which is the more effective and efficient teacher, the computer or the human being?”

Simulation
Simulation programs rely on visual effects to bring real-life situations that
are dangerous, expensive, or time consuming into the classroom. These types of programs provide the student with an opportunity to recreate situations that might be difficult, expensive, or even impossible to replicate in the classroom otherwise. Whether it be a simulated hazardous disposal plant or a nuclear aircraft, students are able to manipulate given situations to acquire skills presented through the software. Simulations are designed to give students an opportunity to learn and use problem-solving skills.

Problem Solving
Problem-solving software is designed to use computer capabilities to enhance the teaching and learning of higher-order problem-solving strategies. Unlike simulations that attempt to model real-life situations, problem-solving software lessons constitute a more general category. This software may be useful in enhancing higher-order thinking skills in educational settings.

Tool
Tool software is used to enhance the teaching and learning process in all subject areas (Sheingold, Hawkins, & Kurland, 1984). Word processors, database managers, spreadsheets, telecommunications software, and graphic packages are examples of tool software. With the help of these, teachers and students are able to concentrate on the development of more sophisticated cognitive skills. Such software allows the computer to do the more tedious tasks. Computer tools act as “cognitive enhancers” to broaden the capabilities of the student (Dede, 1987).

Computers in Educational Programs for Hearing Children
The history of computer-based instruction can be traced back to 1959, when IBM placed teletype terminals in a school and connected the terminals to a large central or mainframe computer (Hoffmeister, 1984). In this early venture, students were seated at terminals for brief periods of educational assistance that can best be characterized as drill and practice. Student interaction with the computer was limited to keying in coded responses, such as single letters, words, or numbers, in response to multiple-response questions. Thus, the early educational programs were limited by the amount of student responses they could handle.

Educational programs for mainframe computer applications were scarce, and those that were available were limited to mathematics and grammar drills (Bell, 1984; Snyder, 1971). Even with a scarcity of software, computer-based instruction was viewed as the educational boon of the future. This positive view of computers in education was fostered by a project that developed computerized educational programs and then evaluated their use in the classroom. In 1963, Stanford University conducted a series of studies investigating the efficacy of computer-based instruction. This project resulted in improved educational software and empirical evidence that CAI was a viable educational tool (Gulberton, 1974; Fletcher & Atkinson, 1972).

Fletcher and Atkinson (1972) studied the influence of CAI on reading achievement test scores. Twenty-two pairs of first-grade boys and 22 pairs of first-grade girls took part in their study. The experimental member of each matched pair received 8 to 10 minutes of CAI in reading per day for approximately 5 months. The control member of each matched pair received no CAI. The results showed that boys and girls who received CAI scored higher on reading achievement tests.

In a review of research on CAI relating to reading, R. Thompson (1990) collected evidence of its effectiveness and concluded that was a useful supplement to traditional pedagogical practices.

Computers in Educational Programs for Deaf Students
Contemporary application of computer-driven programmed learning to education for the deaf has its roots in federal legislation that established the Captioned Films for the Deaf program in 1958. Subsequent legislation broadened the scope of the program to include the training of teachers of deaf students in the use of programmed learning. Through this federal service, hundreds of teachers from schools for the deaf received training in the 1960s and 1970s in the development and use of programmed instruction (Propp, 1978). This early training provided by Captioned Films for the Deaf dealt with paper-and-pencil forms of programmed learning tools, but this set the stage for the eventual introduction of the microcomputers and CAI to schools for deaf children; programmed instruction is the format used in CAI today.

Computer-based instruction in the education of students who are deaf began in 1968 when the Institute of Mathematical Studies in Social Science (IMSSS) of Stanford University began working with the deaf students at Kendall School for the Deaf in Washington, DC (Gulberton, 1974). The IMSSS project grew to include more than 3,000 students in schools for the deaf across the United States. The goals of this program included the development of software and an evaluation of the use of computerized
instruction with deaf students. This early study indicated that deaf students’ math achievement scores increased in direct proportion to the number of computer-assisted instruction lessons they received in math (Culbertson, 1974). The IMSSS study, however, did not address the question of whether CAI would be helpful in the teaching of reading to deaf children.

In 1977, microcomputers were introduced to educational programs for deaf students. Acceptance was apparent in a nationwide poll of programs conducted by Rose and Waldron (1984). They found that the number of schools using computers had more than doubled between 1981 and 1983.

Rose and Waldron (1984) and Harding and Tidball (1982) investigated the ways in which computers were being used in classrooms for the deaf. Both reported that computers were most often used for drill and tutorial purposes. Educational games were used less often than drill and practice programs, and simulation software was reported as being used only rarely. Many teachers reported being unfamiliar with simulation programs.

Some software programs were designed in the 1980s specifically for students who are deaf. Prinz and Nelson (1985) conducted a project at the Pennsylvania School for the Deaf that incorporated microcomputer-generated visual representation of American Sign Language. ASL is a visual-gestural language commonly used within the Deaf community in the United States and Canada. Unlike Signed English, which is a manually coded form of English, ASL is distinct from English in that it has its own syntactic, semantic, and pragmatic systems. Prinz and Nelson found that ASL presented via computer could have a positive impact on speech or sign language production by deaf children. This project revealed significant gains in word recognition when signs were added to CAI programs designed to teach vocabulary.

The importance of interaction between student and software was demonstrated by Prinz (1991). He studied the effects of “recasting” within the context of CAI using interactive videodisc technology. Recasting involves adjusting discourse to provide new information in relation to a child’s utterance. That is, the adult comments on, clarifies, and expands the message produced by the child. Prinz reported mean percentage gains in text skills and general language skills but reported no statistical measurement to indicate significance.

**Videodisc Technology**

Interactive videodisc systems provide a multimedia environment that combines television and computer-based instruction. This technology integrates text, audio, graphics, still images, and moving pictures into a single topic presentation. It offers students a chance to acquire information through both video and audio, and at the same time interact with the computer. The involvement of varied physical senses may provide improved access to written material for deaf and hard of hearing students (Rittenhouse, Kenyon, & Healy, 1997).

Videodisc technology has made it possible to explore a variety of possibilities for using ASL and English concurrently. Hanson and Padden (1990) developed HandsOn, a system that simultaneously presents ASL video and English text. This software addresses the issue of a bilingual ASL/English instructional approach. Students interact with English and ASL in a story context that involves translations between the two languages at the sentence level. Students also get the opportunity to practice writing English sentences and to paraphrase ASL stories into English words. In theory, the method allows the deaf child’s proficiency in ASL to enhance literacy skills in English. However, to date there is no empirical information regarding the efficacy of this approach and this program other than case reports.

Project LITERACY-HI was developed in 1994 as a 3-year study to explore the use of electronically enhanced text with deaf students (Horney, Anderson-Inman, & Chen, 1994). The researchers identified types of electronic text enhancements for deaf students and investigated these enhancements’ effects. This project created electronic versions of textbooks and included multimedia resources designed to support reading comprehension. The ElectroText Authoring System was used to create electronic documents for the project. Horney and colleagues found that it was relatively easy for deaf students to learn basic computer operations, but the students needed guidance in the use of text-based and other resources found in the system. The project was extended for an additional 2 years in order to study the effects of electronically enhanced texts with students who are hearing impaired. Unfortunately, no statistical data has been reported for this project with regard to the improvement of reading comprehension.

**CD-ROM**

A CD-ROM (compact disk—read-only memory) is a laser disc that contains information that is read from a specialized computer drive. Like videodisc technology, CD-ROM comes in interactive and noninteractive formats. A variety of media may be presented on CD-ROM (e.g., sound, still/animated pictures, text, and computer data); hence the application of the term multimedia.

CD-ROM multimedia is becoming a
Effectiveness of Multimedia Reading Materials

widely accepted tool in classrooms for deaf and for hard of hearing students. Multimedia has the potential to allow the deaf child to determine the mode of information presentation best suited to his or her needs. That is, the mode of presentation (e.g., print, auditory, graphics, and sign language—enhanced video) is determined by the deaf child and can be changed or switched at any point in the presentation. It is assumed that such multimedia interactive tools have enhanced pedagogical value. That is, it is assumed that interactive multimedia make it possible for deaf students to forge improved connections between visual and textual elements—that is, among graphics, sign language animation, and written text (Mazaik, 1993).

The variety of presentation modes inherent in interactive multimedia directly relates to the internal symbolic mediators of thought used by deaf people. Most people develop listening and speaking skills prior to learning to read and write. Speech perception theories suggest that a speechlike cognitive representation of a word is necessary if one is to acquire the meaning of that word. This speech-recoding hypothesis, which posits that a printed word must be converted to a phonological equivalent, has been tested in relation to how deaf individuals code, store, and retrieve information. Basic findings indicate that deaf study participants have more coding options than hearing participants do, but there appears to be a mismatch between sign codes (visual coding) and written codes (phonological coding) based on speech (Conrad, 1979; Moutlon & Beasley, 1975). Lichtenstein (1983) found that deaf students used two or more codes to process language-related materials. The most commonly used were speech (phonological) and sign (visual). He reported that deaf students’ limited efficiency in the utilization of coding strategies is directly related to the manner in which the information is coded during the reading of English.

Speech coding appears to be an important component of reading, at least for hearing people. However, it does not necessarily follow that those deaf students who do not develop coding systems based on speech will become reading failures. It may be that alternative means, other than speech, of imparting and presenting information to deaf students is necessary. It could be, for example, that graphics and sign language—enhanced video are viable alternatives to print.

In 1994 Pollard, CAI specialist at the Texas School for the Deaf (TSD), created an interactive CD-ROM based on the popular picture book for children Rosie’s Walk, by Pat Hutchins. It utilized short video clips of Signed English and ASL to the printed text screen. For example, through Pollard’s interactive CD-ROM, deaf readers can choose to supplement print with Signed English or with ASL, or both. In addition, vocabulary and reading skills are addressed through a number of games included in Pollard’s software. This was the first application of CD-ROM-based interactive software to deaf children’s literature. Pollard reported that deaf students in the elementary grades were motivated by and interested in the CD-ROM story (Pollard, personal communication, spring 1997).

In 1997, Pollard also developed a sign language—enhanced CD-ROM of Aesop’s fables. He assembled five CD-ROM multimedia stories suitable for use with middle school deaf students. The multimedia options available in these stories included print, graphics, and sign language. Pollard has presented anecdotal evidence suggesting that such a format may enhance the transfer of information during a reading task involving deaf children, but he has not yet provided supporting empirical data nor attempted to determine the relative strengths of the presentation options. Further, Pollard did not make a distinction between Signed English and ASL (Pollard, personal communication, spring 1997).

Increasingly, educators are using multimedia tools to address deaf students’ reading problems (Andrews, Haas, & Waller, 1987; Andrews & Sinclair, 1989; Pollard, 1993; Stewart, Heeter, & Dickson, 1996). Through multimedia, educators can present reading-related teaching materials in a variety of modes that, it is assumed, can enhance deaf students’ reading skills. Using multimedia technology, teachers of students who are deaf can now use various combinations of print, pictures, sign language—enhanced video, graphics, and animation to teach reading. Though it is assumed that these are powerful teaching tools, little has been done to investigate this assumption.

Although it is assumed that multimedia technology will enhance reading abilities of students who are deaf, there is no empirical evidence to support such an assumption. Therefore, the goal of the present study was to assess the effectiveness of multimedia and available presentation options in improving the reading skills of deaf students. Two research questions were addressed:

Compared to print-only presentation, how effective is multimedia in transferring linguistic information to deaf children?

If multimedia is an effective tool, what is the relative effectiveness of available presentation options? Specifically, what is the relative effectiveness of each of the following:

...
Methods
Using a repeated-measure design for single subjects within groups, we investigated the transfer of print-related factual information to deaf participants. Stories were presented through a variety of multimedia options to deaf students. Story retellings completed by each participant were then analyzed, and scored for accuracy.

Participants and Educational Settings
Twenty-eight deaf students, ages 9 to 18 years, from Louisiana and Texas, were recruited from integrated mainstream school settings and from residential, nonintegrated school settings. Of the 28 students, 3 were eliminated from the study, as school scheduling of classes prevented them from completing the test. Integrated mainstream programs were selected from Calcasieu Parish Schools in Lake Charles, LA; Caddo Parish Schools in Shreveport, LA; Bossier Parish Schools in Bossier City, LA; East Baton Rouge Parish Schools in Baton Rouge, LA; and the Beaumont Deaf Co-op Schools in Beaumont, TX. Residential participants were recruited from the Louisiana School for the Deaf (LSD) in Baton Rouge. Only three participants were volunteered by LSD. It seemed unlikely that only three children from LSD read on a third-to-fourth-grade level, but probably there was a misunderstanding that resulted in the administration providing only the three third-to-fourth-graders who were reading at their academic reading level.

Most of the public school children were in self-contained classrooms with partial inclusion. School programs in which the students communicated orally were not recruited for the study. Participant demographics are provided in Table 1. Consent for participation was obtained following the Lamar University Institutional Review Board’s procedures for use of human subjects in research.

Although teachers’ sign proficiency was not assessed, it was clear to us that teachers were using a combination of Signed English and ASL in communicating with their students. It was also noted by observation that students signed among themselves using ASL. In addition, their story retelling was in ASL. Two graduate students from Lamar University who did measure interrater reliability concurred with this observation for the story retelling.

The study participants met three criteria: (a) third-to-fourth-grade reading levels as determined by scores on the Stanford Achievement Test for the Hearing-Impaired (SAT-HI); (b) at least “average” IQ as documented on 3-year multidisciplinary evaluations provided by the participating school systems; and (c) use of sign language as the primary means of communication, as reported by the classroom teacher.

Procedures and Materials
Multimedia stories on CD-ROM were used as stimuli. The stories were at the third-grade reading level, as determined by the readability scale on WordPerfect 7.0 word-processing software. Specifically, children’s stories were embedded in CD-ROM in a three-media format. Media formats included printed words, pictures, and sign language. Multimedia options allowed the participants to access specific prompts presented in each of four treatments:

- Treatment 1: print only
- Treatment 2: print and pictures
- Treatment 3: print and digital video of sign language
- Treatment 4: print, pictures, and digital video of sign language

ASL or Signed English options (or both) were available to the participants under treatments 3 and 4.

The transfer of factual information was measured by a story-retelling activity suggested by Morrow (1988). Participants were asked to recall or retell various aspects of the stories that were presented through the multimedia treatment options. Accuracy in retelling was determined by scoring specific features (such as setting, plot, theme, and sequence of the story) and subheadings under features (such as main character). Story retelling was documented by means of a score sheet (see Appendix). To prevent confounding test-order effects, the four treatments were presented in random order to each participant. In all treatment conditions, participants received CD-ROM-generated presentation options via a personal computer and were allowed to work at their own pace.

Table 1
Study Participant Demographic Characteristics (N = 28)

<table>
<thead>
<tr>
<th>Mean age</th>
<th>12.3 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age range</td>
<td>8–18 years</td>
</tr>
<tr>
<td>Sex</td>
<td>10 male, 18 female</td>
</tr>
<tr>
<td>Ethnicity</td>
<td>13 Black, 1 Hispanic, 14 White</td>
</tr>
<tr>
<td>School placement</td>
<td>3 residential, 25 mainstream</td>
</tr>
<tr>
<td>Familial deafness</td>
<td>4 deaf family, 24 hearing family</td>
</tr>
</tbody>
</table>
pace. During each treatment, each participant worked independently. For those treatments containing more than a single option (i.e., treatments 2–4), the participant was permitted to move freely among options.

Upon completion of each treatment, each participant used sign language to retell the story to the investigator. The retelling was videotaped for future scoring, per Morrow (1988).

Rater error was assessed through interrater reliability measurement. There were 25 participants in the study, each responding to stories presented through four treatment options, and this resulted in 100 responses to be scored. Three raters, two of them native signers, were employed. A Cohen’s kappa procedure was used to compare interrater reliability. The resulting Cohen’s kappa score of 95 indicated acceptable reliability among the three raters.

A repeated measure analysis of variance (ANOVA) design was used to assess retelling scores under the treatment options. An acceptable alpha level for significance was designated at .01. Tukey’s post hoc analysis was performed to determine specific areas of significance.

**Results**

Twenty-five deaf students were rated on story retellings, with stories presented via the four treatment options. The maximum possible retelling score for each story was 26 points. Two points were awarded for complete answers, 1 for partial answers, and none for omissions and incorrect answers. Mean scores are listed in Table 2.

The repeated-measure ANOVA used to analyze the data revealed significant differences between treatments at a p value of .00001 (df = 3; F = 22.27). That is, participants performed significantly differently when retelling stories presented to them through the different treatment options. See Table 2 for ANOVA results.

The Tukey post hoc analysis, as presented in Table 2, indicated significant differences for story retelling when treatment 1 was compared to treatments 2 and 4. Significant differences were also found when treatment 3 was compared to treatments 2 and 4. There were no significant differences for story retelling between treatment 1 and treatment 3.

There were no significant differences between treatment 1 and treatment 3. Nor were there significant differences between treatment 2 and treatment 4.

The results indicated that comprehension was weakest when the stories were presented in a print-only format. Comprehension was strongest when stories were presented in the print with pictures format.

**Discussion**

Story-retelling data on 25 deaf participants were collected and analyzed. The repeated-measure ANOVA indicated that story presentation by print only was the least conducive to story comprehension, while stories presented via print and pictures were most readily understood. Interestingly, the level of comprehension was marginally higher for stories presented by print and pictures than for stories presented through print, pictures, and sign language.

There was no statistically significant difference when presentations of print plus pictures were compared with presentations of print plus pictures plus sign language, as indicated by the Tukey post hoc analysis. This finding was somewhat surprising because it defied assumptions that children who are deaf and using sign language in their everyday communication would benefit from having sign language given as a reading cue. Perhaps a better way of looking at these results would be to focus on the relative strength of pictures.

In the present study, pictures were shown to be a powerful factor in the...
transfer of factual information during the reading process. On reflection, this should not be surprising since teachers of deaf children traditionally make heavy use of pictures when teaching reading.

It is probable that, among other tools, deaf children develop metacognitive strategies to decode text by using pictures, but the results of the present study and of related research do not provide clear indications of the temporal sequence patterns used. That is, it is not known whether young deaf readers first reference the picture or the text, or if there is perceptual switching or a nearly simultaneous utilization of text and pictures.

It is possible that the temporal patterning and the relative importance of text and pictures vary with text complexity and with the attention-getting value of the pictures. For instance, a deaf reader may pay more attention to associated pictures when text is difficult or when the pictures are interesting (e.g., when they include vivid colors or age-appropriate figures) than when text is easy to understand and the accompanying pictures are lacking in interest.

The use of computer-generated sign language to aid in the comprehension of text is a relatively new phenomenon. Although the participants in the present study were fascinated by computer-generated sign language accompanying print, they were unaccustomed to using print supplemented by sign language for story comprehension. This may have had an adverse effect on story-retelling scores. This is not to say that deaf students, over time, would not be able to use sign language augmentation; with practice it is possible that it may be quite useful for decoding text. This supposition is supported by the fact that in the present study, mean scores for treatments with print plus pictures plus sign language were only slightly less than mean scores for treatments with print plus pictures.

Every participant in the present study appeared to be fascinated by digital video sign language. All were observed switching back and forth between Signed English and ASL, presumably to compare the two modes of sign language. It could be that these participants used ASL to understand the story concepts and Signed English to understand specific components of vocabulary and text within the story. This was evidenced by the participants first choosing to watch the ASL option, then switching to the print plus Signed English mode and, while in that mode, comparing signs with words.

Multimedia presentations such as those used in the present study offer a “multilingual” approach to teaching literacy to students who are deaf. Such students may read a story via the printed text, acquire additional information from pictures, and receive still more information about the story via the digital video. This activity may help bridge gaps between printed text and signed communication.

An interesting idea might be to replicate this study to address weaknesses and, in addition, add a “pictures only” condition. Adding a “pictures only” condition would allow the researcher to assess how much information a child gets from a sequence of pictures with regard to story retelling.

The present study has several weaknesses that do not allow it to be generalized to the field. A noted weakness was in participant recruitment. We were not surprised to find limited numbers of children who were deaf in small public schools reading at a third- to-fourth-grade level. However, when requesting students from the residential school, we were surprised that the school would only provide three students. We assume that the school had more than three students reading on the specific grade level, but perhaps the school misunderstood that the age level of the student did not need to match the required grade level.

Another weakness was that most of the teachers of the participants evidently used a mixture of ASL and Signed English (although they were not specifically tested for sign language skills). This is not just a weakness of the present study but a weakness of many teachers of the deaf. This combination (or pidgin) does not foster a firm language base for any deaf child. Observations of the children in this study indicated that conversations among themselves and during their story retellings on video were in ASL.

Also, given the sample size and the mean of participant recruitment, it would be a mistake to generalize the present study to all deaf children and all classrooms for deaf children. Certainly, 8-year-olds have more difficulty with reading than 18-year-olds. However, children were recruited by schools and were not randomly sampled. This again led to a higher number of girls than boys, the opposite of what normally occurs with deafness. We believe this to be an artifact related to the recruitment process.

**Conclusion**

Our findings suggest that multimedia presentation of reading material is significantly more effective for reading comprehension than is the use of print only. However, the findings also suggest that the use of multimedia presentation is not significantly better than the use of print plus pictures alone. Further, the incorporation of sign language with print but without pictures did not appear to enhance story comprehension.

Implications for the deaf education classroom appear to be that multi-
Effectiveness of Multimedia Reading Materials

Media may be an interesting supplement for reading comprehension. However, in the present study, “print plus pictures” was the most efficacious of all treatments. Further, as indicated by the study results, reading by means of print alone is extremely difficult for children who are deaf. Information provided by the present study suggests that the use of pictures significantly aids the comprehension of written text. However, at this time the addition of sign language to those pictures does not seem to aid comprehension of written text.

References


Appendix

Story Retelling Score Sheet

Retelling Analysis

Story: ________________________________

Points in the story:

Setting: (a) begins story with introduction _____
(b) names main characters _____
(c) score for other characteristics _____

Plot: (a) refers to primary goal(s) or problems to be solved _____
(b) number of episodes _____
(c) names problem/solution/goal attainment _____
(d) ends story _____

Theme: (a) main idea/title _____

Sequence: Retells story in structural order:
setting _____
theme _____
plot _____
episodes _____
resolution _____

(Scoring: 2, proper; 1, partial; 0, no sequence evident)